

HEARING AID WITH A MICROPHONE SYSTEM  
AND AN ANALOG/DIGITAL CONVERTER MODULE.



[The present invention relates to a hearing aid defined in the preamble of claim 1  
5 and to an analog/digital converter module as defined in the preamble of claim 4.]

BACKGROUND OF THE INVENTION

It is known to shield the microphone system of hearing aids against  
10 electromagnetic interference and to configure them with respect to acoustic resonance  
[chambers.] chambers. It is further known about hearing aids processing digital audio  
signals to use an analog/digital converter directly subsequent to the microphone system.

[The] German patent 195 457 60 proposes configuring the analog/digital converter  
with the microphone system into one unit in the hearing aid and to shield both jointly  
15 against electromagnetic interference.

This design incurs a number of drawbacks:

-- Each further development of analog/digital converters on one hand and of the  
microphone system on the other hand requires a new design of the combined, integral unit,  
-- The advantage of one and the same analog/digital converter being combinable  
20 with various microphone systems, or that one and the same microphone system might be  
combined with different AD converters, is precluded as regards lowering the  
manufacturing costs of the individual components,

-- When designing the microphone system, the analog/digital converter, which is integral [with it] therewith, must also be considered in the light of the acoustic resonance chambers directly coupled to the microphone.

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## SUMMARY OF THE INVENTION

The [objective of the] present invention is [to eliminate those drawbacks. This objective is attained by the hearing aid of the initially cited kind as characterized by the features of claim 1,] directed toward a hearing aid device that eliminates or minimizes at 10 least some of the aforementioned disadvantages in the art.

In [the insight of the] accordance with the present invention, the direct mechanical assembly of the analog/digital converter on the microphone system [comprising] comprises a shielding case and remedies the [above drawbacks and moreover] above-noted drawbacks. Moreover, no practical drawbacks are sustained regarding electromagnetic shielding 15 because the acoustic resonance spaces and the design of microphone/digital-analog-converter will not be degraded, while shielding remains optimal. Such a result is attained in a preferred [embodiment in that] embodiment, wherein the analog/digital converter is modular and is [encapsulated per se] encapsulated, per se, in a shielding case [which when assembled] which, when assembled, on the microphone system's shielding case can be 20 placed snugly with vanishing conduction gaps, on the microphone system's shielding case so as to be at its potential.

In a further preferred embodiment, the microphone system and the analog/digital converter not only are each modular and undetachably joined, but the two modules may also be joined detachably.

In order to fully exploit the advantage of the design of the invention, in particular  
5 its modular aspect and the flexible use of one and the same analog/digital converter module for different applications, in particular different microphone systems, the invention ~~proposes~~ includes an analog/digital converter module fitted with at least two analog inputs of different input impedances and/or different signal gains.

~~The invention is elucidated below by embodiments shown in the drawings.~~

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#### BRIEF DESCRIPTION OF THE DRAWINGS.

These and further features of the invention will be apparent with reference to the following description and drawings, wherein:

Figs. 1a - 1d schematically show the design, with different shielding concepts, of  
15 a unit of a microphone and an analog/digital converter,

Fig. 2 schematically and in simplified manner shows a cross-section of the apparatus of the invention, and

Fig. 3 schematically shows a preferred embodiment of a module of an analog/digital converter of the invention.

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#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 1] Figs. 1a-1d schematically shows [embodiment] modes of the microphone system with a directly subsequent analog/digital converter of an (omitted) hearing aid. In Fig. 1a, a microphone system 1 is shielded against electromagnetic interference by a shield 3. The analog/digital converter 5 is [mounted in the manner of the invention] mounted, in accordance with the present invention, on the shield 3 of the microphone system 1. In Fig. 1b, a further shield 7 is mounted at the output side of the analog/digital converter in particular also for the purpose of suppressing any electromagnetic interference from the output of [said] the analog/digital converter being fed into its analog input. This feature is optimized in Fig. 1c in that the analog/digital converter 5 is per se [is] encapsulated in a shield 7a. [This embodiment] The illustrated variant is preferred because [allowing] it allows modular use [per se] of the analog/digital converter 5 regardless of how and where further shielding is provided. In Fig. 1d the shield 7b of the analog/digital converter 5 is interrupted at one side, where [it] shielding is completed by the shielding of the microphone system 1. In this instance, the outside shape of the microphone system, [i.e.] i.e., its shield 3 and the design of the analog/digital converter 5, are interrelated.

Fig. 2 illustratively and schematically shows the design of the combination of the [inventions of] microphone system and analog/digital converter. The shielding case 13 of the microphone system 10 is fitted with an acoustic input 11 and supports a flexible sheet 15 coated with conducting paths 17 of the digital output of [said] the converter. The analog/digital converter 16 is encapsulated in a thin shield [17 which is complemented by] 17. The thin shield is preferably a metallized layer [indicated by] 17c of the sheet 15 and sits snugly enough on the shielding case 13 to be at [its] potential. As indicated in merely schematic manner, [the same electrical potential as the case 13. As is schematically]

illustrated in Fig. 2, the analog/digital converter is contained within the shield 17. ~~Also shown but only schematically.~~ Also, the analog input  $I_A$  of ~~said~~ the converter passes ~~both~~ through both the sheet 15 and the corresponding zone of the shield 17 into the case 13 of microphone system 10.

5        In a preferred manner and, as shown in Fig. 3, especially as regards the modular use of the analog/digital converter of the invention, ~~said~~ the converter shall be basically applicable with different input configurations. Illustratively, it may have at least two inputs  $I_1$  and  $I_2$  of different input ~~impedances  $Z_1$  and  $Z_2$~~  impedance,  $Z_1$  and  $Z_2$ , and/or with different input ~~gains  $G_1$  and  $G_2$~~  gains,  $G_1$  and  $G_2$ , and where called for with different 10 analog/digital conversion functions. As a result, the analog/digital converter allows flexible application in different microphone systems.

While the preferred embodiments of the present invention have been illustrated and discussed hereinbefore, it is understood that the present invention is not limited thereto. Rather, the invention is defined by the claims attached hereto.